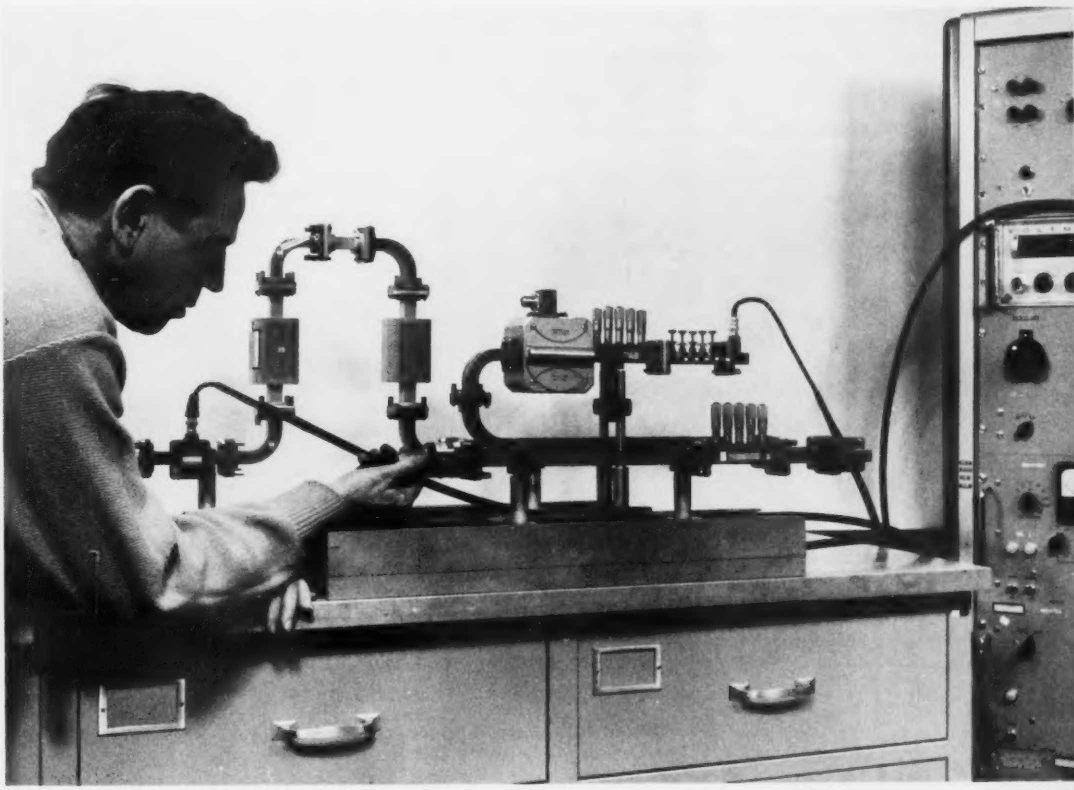
NATIONAL BUREAU OF STANDARDS March 1966

Technical News Bulletin



U.S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

Technical News Bulletin

MARCH 1966/VOL. 50, NO. 3/ISSUED MONTHLY

U.S. DEPARTMENT OF COMMERCE
John T. Connor, Secretary

NATIONAL BUREAU OF STANDARDS
A. V. Astin, Director

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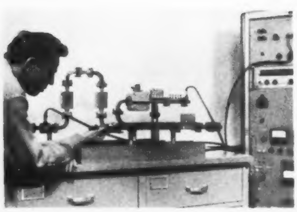

Gerald J. Harris connects a bolometer unit to a transfer instrument (reflectometer) used to measure power accurately in the frequency range 7.05–10.0 GHz. Bolometer units and bolometer-coupler units in WR112 waveguide, that serve as interlaboratory standards, are calibrated in terms of a microwave microcalorimeter used as the reference standard. (Story on p. 45)

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized into three institutes—
- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of all three institutes.

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Calibration of

GAS METER PROVERS

New Method Evaluated

■ Much of the billions of dollars worth of gas used each year for domestic heating and cooling in the United States is measured by gas meters like those often seen in the basements of homes. The accuracy of such a meter is determined by passing through it a volume of gas which is measured by a working standard called a "meter prover." The prover is essentially a hollow cylinder, called the "bell," suspended with its open end in a tank of sealing oil; the volume of gas displaced as the prover bell is moved up or down is indicated on a scale attached to it. The prover in turn must be calibrated. In the past this has commonly been done by "bottling"—a process in which the indications of the prover are noted as successive charges of air are passed into it from a "bottle" nominally holding a cubic foot.

Recently an alternative method of dimensional calibration for which no bottle is required, has been proposed. A study by the NBS Institute for Basic Standards has shown that the newer method is relatively simple and straightforward, and that it is not as susceptible as the traditional one to some types of error.[1]

The bottling method has been common for about 40 years. It has the advantage that the cubic foot bottles can be sent to NBS for calibration. In this way the gas meter in the consumer's home can be linked to the national standards.

In 1964, however, a large manufacturer of meters and provers announced the development of a method of calibrating provers that was in some ways superior to bottling.[2] This manufacturer urged the Bureau to report on the second method, as it had done bottling decades ago.[3]

The newer method is relatively simple and involves only direct measurement of the prover's external dimensions and the levels of sealing fluid in it during its operation. The computations are simple and straightforward. The method is familiarly called "strapping" because the outer circumference of the bell is measured by passing a steel tape around it, like a belt or strap.

The strapping method was carefully evaluated in the NBS fluid metering laboratory while being used in calibrating volumetric standards maintained at the Bureau. The new method was found to have several advantages, foremost that it is almost wholly insensitive to temperature, in contrast to bottling, in which serious errors can be introduced by changes in temperature.

Of particular interest to inspectors and officials who must travel from place to place is the fact that all the measuring tapes and micrometers needed for strapping are small enough to carry in one hand. This is in contrast to the cubic foot standards, which are bulky and contain a sealing liquid which must be drained before the standard is transported.

Descriptions of the two methods and a discussion of the advantages of each method were presented to the gas industry by C. T. Collett, of the NBS Institute for Basic Standards, in papers delivered at a course in gas measurement and at a later gas distributor conference.[1]

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[1] Calibration of bell provers by dimensional analysis and by cubic foot standards, *by Charles T. Collett, in the Proceedings of the Twenty-fourth Appalachian Gas Measurement Short Course 1964, Tech. Bull. No. 73, Engineering Experiment Station, West Virginia University (Morgantown, W. Va.), and Proceedings of the American Gas Association, Operating Section, 1965 Distribution Conference, 65-D-132 (Minneapolis, Minn.)*

[2] Calibration of bell provers, *by H. V. Beck, Am. Gas Assoc. Monthly* **46**, *30–32 (Sept. 1964)*.

[3] Gas measuring instruments, *NBS Circular 309 (1926)*.

Calibration of a meter prover by "strapping." Meters measuring gas used in homes and industry are calibrated by passing a known volume of gas through each meter to or from a meter "prover." Charles T. Collett measures the diameter of a prover bell to perform calibration by a method which is called "strapping" because it uses a strap-like measuring tape.

The simulated blood circulatory system developed for transducer experimentation consists of a drive mechanism (on upper shelf), a pump (at left of drive), and a glass tube rising to a blood reservoir. Merlin Davis (right) adjusts the speed of blood flow past an electrode in the "artery," while Clifford Lowe operates the signal-processing circuitry and recorder.

BLOOD-FLOW SENSOR

Rate of Flow Related to Electrical Conductivity

■ One of the things that medical scientists would like to be able to do is to measure blood flow in the human body without having to use operative techniques. Long-term research on ways of measuring blood pressure and flow, conducted at the Bureau for the Veterans Administration, has revealed new information about the electrical properties of blood. As a result, the relationship between blood flow and conductivity is now better understood, and previously unchallenged assumptions about electrode placement and configuration have been corrected. The NBS team, composed of Merlin Davis, W. D. Hampton, and C. E. Lowe, Jr., also developed and tested a prototype blood-flow sensing system in its work for Dr. Edward D. Freis of the VA.

New ways of measuring blood pressure and flow which the Bureau has devised and instrumented for the VA should be of interest in cardiological, pharmacological, and psychological research. Under this program NBS has already produced an arterial pulse wave-form transducer which responds when pressed against the patient's skin overlying an artery.[1]

Experimental blood-flow instrumentation has been tested with simulated circulatory systems at the Bureau's instrumentation laboratories and on animal subjects. It offers two advantages over other conductivity-type flow indicators: it can be used with only one electrode inserted in the bloodstream and it depends on a stable mathematical relationship. The instream electrode is small enough for use in a catheter, a flexible tube with which the electrode can be inserted into a blood vessel and positioned throughout much of the bloodstream. The other electrode makes contact with the subject's skin.

Conductivity of Flowing Blood

Previous experimentation, both at the Bureau and elsewhere, has been directed at measuring the conductivity of blood as an indication of flow rate. In this program, the Bureau scientists studied various placements and sizes of electrodes, both previously used and new. Closely spaced electrodes—separated by 1/32 inch, for example—were found to conduct in inverse proportion to flow rate, a phenomenon not yet entirely under-

A laboratory pump enabled Bureau scientists to correlate blood flow and conductivity for various electrode configurations and placements. In operation the white plunger at the right forces glycerin from the pump body (clamped between wooden blocks) into a chamber at the left, squeezing a rubber sac clamped over the opening. W. D. Hampton, holds a sac like the one already in place, and the cap to be clamped over the port. The sac, cap, tubing, and reservoir above (not visible) will be filled with blood, which will circulate back and forth with strokes of the plunger.

stood. The conductivity between electrodes more widely spaced in the bloodstream, on the other hand, was found to increase with flow rate but to tend to saturate at higher rates in tests at the Bureau and elsewhere.

A significant finding from laboratory simulation of blood flow was that in measuring conductivity only one of the two electrodes must be in the flowing portion of the stream; the other electrode may be placed in a relatively quiescent portion of the stream. A second significant finding was that with the electrodes so positioned the conductivity was a cube-root function of the flow rate. As yet, the reason for this precise cubic relationship is not known; other fluids do not behave in this way, not even those containing cells analogous to red corpuscles (the movement of which apparently is actually measured as conductivity).

Flow Rate Instrumentation

The instrumentation devised by the NBS team to determine flow rates uses electronic, optical, and mechanical components. It consists of an electrode-tipped catheter, an external electrode, signal circuitry, and cubing and recording circuitry. An a-c signal at 2400 Hz is imposed at a fraction of a volt across the blood path in series with one arm of an automatically balanced electrical bridge. Pulsatile flow imposes amplitude modulation on the signal, which is amplified and the modulation detected. The modulation is compensated electrically for an apparent time lag of corpuscle movement and applied to position an opaque plate with a third-power exponential opening cut in it. Light passing through both the opening and a slit in another opaque plate across it is sensed by a photocell and applied to a strip recorder.

Laboratory "Heart"

One of the initial problems to be solved was the design of a pump to simulate the heart's function. Mr. Davis and his colleagues constructed one in which an eccentric-driven piston forces glycerin in and out of a cavity. A rubber sac containing the blood to be pumped is located in this cavity. The glycerine exerts a pulsatile pressure on the sac, thus pumping the blood through the measuring tube.

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[1] Electrical device shows patient's pulse, *NBS Tech. News Bull.* **49**, *165 (Oct. 1965)*.

NBS RADIO STATIONS

Standard Frequency and Time Broadcasts

In accordance with National Bureau of Standards policy of giving monthly notices regarding changes of phases in seconds pulses, notice is hereby given that there was no change in the phase of seconds pulses emitted from radio station WWVB, Fort Collins, Colo., on February 1, 1966.

Notice is also hereby given that there was no change in the phase of time pulses emitted from radio station WWV, Greenbelt, Md., and WWVH, Maui, Hawaii, on February 1, 1966. These pulses at present occur at intervals which are longer than one second by 300 parts in 10^{10}. This is due to the offset maintained in frequency, as coordinated by the Bureau International de l'Heure (BIH).

FLOATING WEATHER STATION

uses nuclear power

■ A nuclear-powered model of the NOMAD weather buoy, developed by the Bureau for the Bureau of Naval Weapons, is now broadcasting weather information at regular intervals from the Gulf of Mexico to monitoring stations ashore. Operating completely unattended, the floating station transmits both general weather data and advance warning of hurricanes.

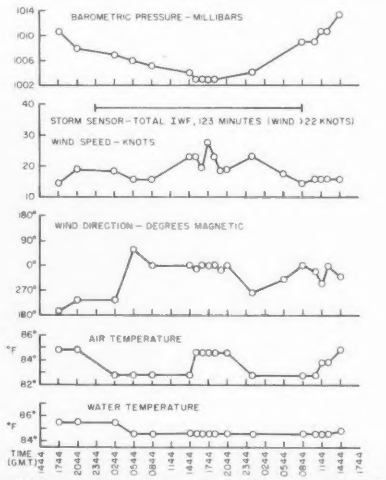
The original NOMAD (*N*avy *O*ceanographic *M*eteorological *A*utomatic *D*evice)[1] was developed in 1955 by William Hakkarinen and P. D. Lowell of NBS. A present NOMAD, many modifications and many years later, is powered from batteries kept charged by a SNAP–7D nuclear generator. This nuclear power supply was developed by Martin Marietta Corporation for the Atomic Energy Commission for long-term, unattended applications. This NOMAD was prepared for service by Mr. Hakkarinen, Fred H. Sanders, and Lewis Wilson of the Bureau staff.

The NOMAD anchored in the Gulf of Mexico will soon be joined by additional NOMADs placed out of Norfolk, Va., and San Diego, Calif. Each station will broadcast the following weather data, using the continental code: station identification, water temperature, air temperature, barometric pressure, wind speed, wind direction, and integrated wind force. Each transmission takes about two and one-third minutes and can be programmed to occur at intervals of 1, 3, 6, or 12 hours. These transmissions should aid in predicting the arrival of storms early enough for ships and planes to change course and for populated areas to make preparations.

Instrumentation

The 1955 NOMAD consisted of a 10 × 20-foot nonmagnetic float, designed by the Navy's David Taylor Model Basin and containing circuitry powered by dry batteries. The present model looks much like the first one, but uses improved circuitry and a nuclear power source. Many of its sensors, however, are similar to those of previous models. Temperatures of the air and water surface are measured by thermistors having a

Left: *Navy weather data station NOMAD being anchored in the Gulf of Mexico. Modifications used in this model include the SNAP-7D nuclear generator, which keeps the batteries charged for several transmissions daily of weather data at a power of about 4 kW. Weather-sensing devices visible in the photograph include the anemometer, the wind-direction indicator, and the IWF-storm sensor; not visible are thermometers and a barometer. The radio circuitry, batteries, and nuclear power source are inside wells, below the hinged covers visible on the deck.* Right: *Meteorological information was transmitted during Hurricane Betsy by NOMAD. It was received and recorded at a Federal Communications Commission station at Fort Lauderdale, Fla., beginning September 8, 1965.*



high negative temperature coefficient. Barometric pressure is converted to a resistance value by clamping the conductive pointer of an aneroid barometer to a circular resistance strip at the moment of sensing. Similar methods are used to sense wind speed and direction; the former is presented by a tachometer driven by a three-cup anemometer and the latter as the position of a magnetic pointer. IWF (the amount of time that the wind speed has exceeded a threshold value) is obtained from a multiturn potentiometer positioned by a d-c chronometric motor controlled by a pressure-plate anemometer.

The resistance values supplied by these transducers are switched in a fixed sequence into a self-balancing bridge. When balanced the bridge controls a selector and code generator which expresses transducer resistance in terms of the continental code. The generator keys a pulse-modulated transmitter operating at 5340 kHz and a power of about 4 kW. This signal can be received reliably over a distance of about 1300 km (approximately 800 miles) and has been reported to have been received over a path of over 2700 km. Excellent reception over 800 km was obtained during a recent hurricane.

Power Sources

Electrical power to operate the telemetry circuitry and navigational lights of the NOMAD anchored in the Gulf of Mexico is supplied by three series-connected, 4–V nickel-cadmium batteries which are kept charged by the 50-W SNAP–7D nuclear generator. The SNAP–7D, which is mounted below the deck, is a thermoelectric generator operated by heat from the nuclear source.

Each of the other NOMADs in use obtains its power from 12–V, lead-acid batteries providing a capacity of 4000 ampere-hours. Two wind-chargers mounted atop masts charge these batteries sufficiently for station operation over a practical length of time. Both models of NOMAD use 12 Vdc—110 Vac converters to power some station functions.

Ground Tackle

During the years in which successive models of NOMAD have been anchored, Mr. Hakkarinen has experimented with different configurations of ground tackle to moor the float against the stresses of gusts and hurricanes. The NOMAD in the Gulf is anchored in a depth of about two miles by means of a mooring bridle, from which 305 m of stainless-steel-wire rope descends to 2286 m of nylon line, which in turn leads to another 2286 m of polypropylene line. This is attached to an iron chain, a 571-kg ballast ball, and a one-ton mushroom anchor. All fittings in the system above the iron chain are of stainless steel.

[1] *For information about an early model of NOMAD, see,* An ocean-based automatic weather station, *NBS Tech. News Bull.* **40,** *38–39 (March 1956).*

Standard Materials

Publication on Radioactivity Standards

A recent publication in the Standard Reference Materials series, NBS Miscellaneous Publication 260–9, gives the values of the half lives of materials used to prepare 19 radioactivity standards issued by the Bureau.[1]

The publication contains previously unpublished data obtained from many years' study of the materials used to prepare these standards. Because of variations in reported values of half-lives, these data are being presented so that appropriate decay corrections may be applied by users of the standards. The publication also discusses methods of determining half-lives, instrumentation, source preparation, and the determination of impurities involved in the radioactivity standards. This publication should be of interest not only to users of NBS standards, but also to those who handle radioactive materials, measure its radiations, and deal with its purity.

[1] Standard Reference Materials: Half lives of materials used in the preparation of standard reference materials of nineteen radioactive nuclides issued by the National Bureau of Standards, *NBS Misc. Publ. 260–9, available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, for 15 cents.*

Renewal Standards

The following standard reference materials have recently been made available by the Office of Standard Reference Materials to replace out of stock standards:

(1) Basic open-hearth steel, 0.4 percent carbon, No. 12h, replaces No. 12g and costs $12 per sample.

(2) Nickel-chromium cast iron No. 82b, replaces No. 82a and costs $15 per sample.

(3) Cement No. 114k, replaces No. 114j and costs $2.50 per sample.

(4) Low-carbon, silicon steel No. 131a, replaces No. 131 and costs $12 per sample.

(5) Basic open-hearth steel, 0.5 percent carbon, No. 152a, replaces No. 152 and costs $12 per sample.

(6) Plutonium metal No. 949a, replaces No. 949 and costs $34 per sample.

(7) Surface flammability standard No. 1002a, replaces No. 1002 and costs $8 per sample.

In addition, renewals of six metallo-organic standards have been made available; each standard costs $15.

(8) Cupric cyclohexanebutyrate No. 1056a, replaces No. 1056.

(9) Dibutylin bis(2-ethylhexanoate) No. 1057a, replaces No. 1057.

(10) Manganous cyclohexanebutyrate No. 1062a, replaces No. 1062.

(11) Menthyl borate No. 1063a, replaces No. 1063.

(12) Strontium cyclohexanebutyrate No. 1070a replaces No. 1070.

(13) Triphenyl phosphate No. 1071a, replaces No. 1071.

Philip Stein removes a module from stock for use in an automatic datalogging system being assembled. This and other modules will be mounted on a rack and interconnected to form a system measuring and recording experimental data automatically at programmed intervals. When the experiment is completed, the system can be dismantled and the modules returned to stock for later use.

TRANSISTORIZED MODULES

for datalogging systems

■ The NBS Center for Computer Sciences and Technology has demonstrated that most types of special-purpose, automatic data-recording equipment used by NBS laboratories can be built in only days from modules developed and stockpiled at the Center. Design and assembly of a data-handling system are speeded by breaking it up into specific functions and assigning flexible modular building blocks to perform each. A relatively small number of module types in the stockpile is sufficient to construct a large variety of special-purpose data-recording systems.

Frequently used modules have been designed by Don R. Boyle, Alfred L. Koenig, and Philip Stein, of the Bureau's Center for Computer Sciences and Technology, making use of a family of NBS-designed printed circuit cards. When fabricated, the modules are tested and stocked, ready for use. Assembly of a system consists, in the simplest case, of mounting the necessary modules in a rack, interconnecting them, and wiring the system to the data source.

Collecting Data by Machine

Many errors can creep into data collected and recorded manually—errors in reading meters, entering data, and punching cards or tape, for example. These are eliminated, however, from data that are automatically transcribed and prepared for computer use. A system for doing this also reduces the delay between data collection and data analysis.

Machine methods of collecting data are used not only for accuracy and convenience, but also to make possible experiments that could not be performed otherwise. This is the case with experiments producing data either too fast for a human to record them or, conversely, infrequently or irregularly over too long a period of time to justify continual attendance.

NBS Datalogging Systems

The systems assembled at NBS automatically obtain and record data from unattended experiments at rates up to 50 datum points a second. The system can also be programmed to vary experimental parameters, such as voltage or wavelength. The data are usually recorded on a computer-compatible medium, such as magnetic or paper tape, so that they can be read without error directly into a computer for processing and interpretation.

Each of the modules developed at the Bureau contains its own power supply and requires only line power, signal inputs, and programming of its functions. The modules and their maintenance are simplified by design around a card cage accommodating up to 20 logic cards. The cards are redesigned versions, designated MAD–1A,[1] of previously used printed circuit cards. They employ improved transistor types and circuitry configurations offering greater component density, and hence greater spatial efficiency. The modules available, each contained in a $5\frac{1}{2}$-in. high, rack-mounting chassis, are the following:

1) *A programmable control module,* which supervises the sequence of operations, varies experimental parameters, synchronizes data points with a clock, and controls the functioning of the system.

2) *Scanners and multiplexer modules,* which enable more than one digital or analog signal source to be connected to the system's main data path.

3) *Analog-to-digital converter*, one of several commercial types compatible with NBS modules, used to convert analog voltage values to digital form.

4) *Paper-tape reader modules*, used to read, from paper tape, special instructions on parameters to be applied to the experiment.

5) *Event or event-per-unit-time counter* to collect data presented in the form of frequency, period, or time, as well as number of events.

6) *Registers*, used for temporary storage of digital data pending output.

7) *Output modules*, used to control commercial data output devices, such as digital magnetic tape recorders, paper tape punches, and automatic typewriters.

For some problems, it is necessary also to devise a unique interface module to solve the connection difficulties encountered in the particular application.

Using Dataloggers

A typical experiment using a modular datalogging system might require measuring the amplitude of light emitted from a source and passing through a transmission spectrometer. Such a system might consist of an analog-to-digital converter, a register, and an output module capable of recording the values of transmitted light in digital form. A control module and digital shaft encoder could be added to record also the wavelength corresponding to each reading. Further elaboration might consist of adding a tape-reader input module and digitally controlled motor so that the experimenter could program, via punched tape, the wavelengths at which readings were to be taken. The system would read the tape, set the wavelength emitted by the monochromator, measure the amplitude of light transmitted, and record both the wavelength and light intensity.

The flexibility of existing modules allows such systems to be constructed without additional engineering. The example shows how modifying or adding to a system can be done simply by adding modules and changing the control module program. The original equipment remains useful to the laboratory after an experiment changes. Modules no longer in use can be returned to the module stockpile and reused without becoming obsolete.

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[1] Transistorized building blocks for data instrumentation, III, *by Philip G. Stein, NBS Tech. Note 268 (in press, to be available early in 1966 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402)*.

Automatic datalogging equipment is programmed by Don Boyle. Modules from the Center's stock were interconnected to form this system, custom-designed for a task in a Bureau laboratory. System operation is programmed at the plugboard and the digital data are recorded on magnetic tape.

Modules mounted in the cabinet at the left form a datalogging system designed especially to record microdensitometer readings. Myron Berkovitz inspects the visual presentation of the microdensitometer (lower right) as Alfred Koenig adjusts a digital voltmeter. The data indicated by the voltmeter and recorded by the tape recorder in the drawer beneath have been prepared by the NBS modules below.

Spherical alloys give

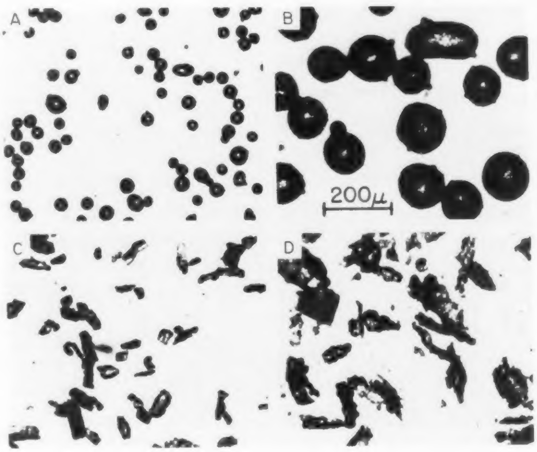
IMPROVED DENTAL FILLINGS

■ Silver alloys atomized into tiny droplets have improved properties for dental applications, according to recent findings at the NBS Institute for Materials Research in work sponsored by the Federal Dental Services. These spherical alloys, as they are called, are mixed with mercury in the traditional manner for preparing dental fillings. The resulting amalgams have high strength and adapt more easily to the shape of a tooth cavity than do conventional amalgams. The new type of dental alloy is expected soon to be on the market.

The effects of alloy particle size on the physical properties of dental amalgams were investigated earlier at the NBS dental research laboratory.[1] The work revealed a strong dependence of amalgam properties on particle size and shape and suggested the use of spherical alloys to gain better control of these properties.

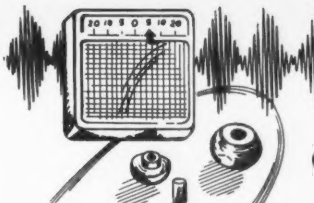
In a recent continuation of this work, Lt. George Eden DC–USN, an NBS guest worker, and Richard M. Waterstrat, research associate of the American Dental Association at NBS, have studied amalgams made with spherical alloys and with conventional alloys of irregular particle shape under identical test conditions. When the amalgams were packed under low constant pressures in cylindrical molds, the spherical alloy amalgam produced excellent cylindrically shaped specimens with no visible surface defects. The conventional amalgams, however, did not conform to the shape of the mold; instead, they retained their lumpy condition.

Moreover, in tensile tests, the spherical alloy amalgams maintained their high strengths at low packing pressures whereas the conventional amalgams rapidly lost theirs. These findings indicate that when the new type of alloy becomes available commercially it will permit dentists to obtain high strengths in cavity areas that are difficult to pack properly. Such areas occur at the margin between the tooth and the filling and in crevices that are difficult to reach with a packing instrument. Thus the dentist may achieve better results with less effort. At the same time, the patient will be subjected to less discomfort than is now the case.



A and B are cylindrical specimens of conventional amalgams made at a low packing pressure. The conventional alloy particles are shown in blocks C and D (below). Specimen 5 is made with the spherical alloy at the same low pressure. These spherical alloy particles are shown in block A (below); larger particles sizes are shown in block B.

[1] Properties of dental amalgams made from spherical alloy particles, *by N. C. Demaree and D. F. Taylor, Journal of Dental Research* **41**, *890 (1962)*.



STANDARDS AND CALIBRATION

Metrologia

The current issue of *Metrologia*, rounding out its first year, has three articles on temperature and its measurement and one on astronomical time. In Letters to the Editor, W. K. Clothier (NSL)[1] describes a proposed absolute liquid electrometer; and A. H. Cook (NPL) gives the result of a new absolute determination of the acceleration of gravity. An index covers the four issues of volume one.

An improved electronic thermometer based on nuclear quadrupole resonance is described by J. Vanier (VA). A small high-Q coil packed in powdered potassium chlorate is the probe; the sensitive nuclei are those of chlorine. A single instrument covers 10 to 450 °K; and it is found that with $KClO_3$ recrystallized from commercial reagents the intrinsic reproducibility is ± 0.001 deg K at 77 °K, which would make it suitable as a laboratory standard. Also described is a method of determining the center frequency which would permit a sensitivity of ± 0.0002 deg K.

J. A. Hall (NPL) compares temperature determinations based on monochromatic blackbody radiation with thermodynamic gas-thermometer values obtained by applying corrections to measurements made according to the IPST. Experimental methods are discussed in detail and the result of a new determination of the gold point is reported.

"Temperature as a basic physical quantity" by J. de Boer (ITP) starts with a historical introduction, then explains the thermodynamic definition of temperature and that based on canonical ensembles. The author's remarks stress the equivalence of the two definitions, with some attention to negative temperatures. Four methods of realizing the thermodynamic scale—based on laws of ideal gases, paramagnetic and nuclear magnetic substances, and blackbody radiation—are discussed, and there is a brief consideration of the IPST. Towards the end are remarks on the "basic" character of the temperature concept, and it is argued that proposals to change its definition have not thus far offered significant improvements.

"Astronomical time" by J. Kovalevsky (BL) deals with "time scales," systems for arranging events in a single temporal order, as opposed to just establishing a unit of time interval. The aim is to show why astronomers must use several time scales in order to carry on their work, despite the fact that some of the scales are, in a sense, incompatible with a constant unit of time and others lead to a unit that is less precisely realizable than that available from atomic clocks.

Measurement of Microwave Power in WR112 Waveguide

(7.05–10.0 GHz)

The Radio Standards Laboratory of the NBS Institute for Basic Standards, Boulder, Colo., announces a calibration service for the measurement of effective efficiency and calibration factor of bolometer units and bolometer-coupler units in WR112 waveguide. Although calibrations can be performed within the useful range of the waveguide, some degree of economy to the customer results if calibrations are performed at the selected[1] frequencies of 7.75, 8.50, and 9.00 GHz.

The quantities measured in the new service are defined as follows:

Effective Efficiency for Bolometer Units: The ratio of the substituted d-c power in the bolometer unit to the microwave power dissipated within the bolometer unit.

Calibration Factor for Bolometer Units: The ratio of the substituted d-c power in the bolometer unit to the microwave power incident upon the bolometer unit.

Calibration Factor for Bolometer-Coupler Units: The ratio of the substituted d-c power in the bolometer unit on the side arm of the directional coupler to the microwave power incident upon a nonreflecting load attached to the output port of the main arm.

In the interest of speeding up the availability of a service for the calibration of bolometer units and bolometer-coupler units in WR112 waveguide, the working standards in WR112 waveguide were calibrated indirectly by means of an existing microwave microcalorimeter that was designed specifically as a reference standard for power measurements in WR90 waveguide (8.20–12.4 GHz).[2] In making such measurements, a bolometer unit of WR90 waveguide, calibrated previously in the microcalorimeter at the WR112 frequencies, is used in combination with a bolometer unit of WR112 waveguide. Although a discontinuity exists in the waveguide between the two units (no transition

(Continued on page 47)

[1] *Abbreviations used in this article: NSL=National Standards Laboratory, Chippendale, Australia. NPL=National Physical Laboratory, Teddington, England. IPST=International Practical Scale of Temperature. VA=Varian Associates, Bedford, Mass. ITP=Institute for Theoretical Physics, University of Amsterdam. BL=Bureau des Longitudes, Paris.*

NBS HONORS STAFF SCIENTISTS

Four Receive Stratton and Rosa Awards

On December 17, 1965, the National Bureau of Standards presented to four NBS scientists the two highest honors that it is capable of bestowing upon its own staff members. Two outstanding Bureau men, Dr. Harry Allen and Dr. Deane B. Judd, were given the Samuel Wesley Stratton Award, presented each year in recognition of outstanding scientific and engineering achievement in support of the NBS mission. At the same ceremony, two world-renowned scientists now retired from the Bureau, Dr. Lauriston S. Taylor and Dr. Gordon M. Kline, received the Edward B. Rosa Award, bestowed annually by the Bureau for outstanding achievement in the development of standards of practice.

Dr. J. Herbert Hollomon, Assistant Secretary of Commerce for Science and Technology, presented a bronze plaque to each recipient. With each award went a $1,500 honorarium, which was presented by Dr. Allen V. Astin, Director of the Bureau.

The Stratton Award, founded in 1960 and first given in 1962, is named for the first Director of the National Bureau of Standards. In 1901, Dr. Samuel Wesley Stratton set about to organize NBS as a unique scientific institution. During his 21-year tenure of office, he firmly established the Bureau's position in the scientific and industrial community. Dr. Stratton left NBS in 1922 to become the ninth president of Massachusetts Institute of Technology. Each year, before the award is made, advisors from outside the Bureau are consulted in order to assure objectivity in the selection of the staff member or members whose achievements contribute most in support of the NBS mission.

Dr. Allen, Deputy Director of the Institute for Materials Research, was cited for "distinguished research contributions to infrared and quadrupole spectra of molecules and for leadership in advancing high resolution analysis of asymmetrical molecular tops." In his specialty, determination of the structure and behavior of molecules by the way in which they give off or absorb infrared light, Dr. Allen is considered to be among the country's leading authorities. At the relatively early age of 45, Dr. Allen has been Chief of the NBS Analytical and Inorganic Chemistry Divisions and of the Inorganic Materials Division, and has held his present position since last year.

Dr. Judd, Assistant Chief of the Metrology Division, was cited for "major basic contributions to the science of color measurement and color vision, and the development of color standards for business, science, and industry." In 38 years with the Bureau, Dr. Judd has become probably the world's leading authority on the measurement of color. With a uniquely broad and keen knowledge of physics, psychology, and mathematics, he has worked on problems ranging from standards for color measurement, to camouflage and color blindness.

The Rosa Award was named for Dr. Edward B. Rosa, a member of the Bureau's original staff and its first Chief Physicist. Throughout his career, Dr. Rosa was active in the development of standards of practice and made important original contributions to fundamental standards in the field of electricity and photometry. The Award gives recognition to outstanding acomplishments in the field of standards of practice—the standards by which industry judges its operations, its production processes, and the quality of its products. The technical and committee work on standards of practice are exceedingly demanding, requiring the highest degree of technical competence and administrative skill.

Dr. Taylor and Dr. Kline both retired before the Rosa Award was established last year. Because their past services to science and industry almost ideally exemplify the type of achievements the Rosa Award is meant to recognize, they were selected for the honor.

Dr. Taylor, a leading authority for nearly four decades on the protection of human beings from radiation, was cited for "outstanding leadership and significant individual contributions in the development of national and international standards for radiation protection." Dr. Taylor was with NBS from 1927 through 1964. During that time he was Chief of the Radiation Physics Division and, most recently, an Associate Director of the Bureau. He is now a Special Assistant to the President of the National Academy of Sciences.

Dr. Kline, who is internationally known for his research on the physics and chemistry of plastics, was cited for "outstanding leadership and significant individual contributions in the development of national and international standards in the field of plastics." Dr. Kline was Chief of what is now the Polymers Division of NBS, from 1951 until his retirement in 1963. He is still active as an NBS consultant, writing and editing, and serving on a number of national and international technical committees.

Left to right: *Dr. L. S. Taylor and Dr. Gordon Kline, recipients of the Rosa Award; Dr. Allen V. Astin, NBS Director; Dr. Harry Allen and Dr. Dean Judd, Stratton Award winners, pose before portraits of two former Directors, Samuel Wesley Stratton (left), for whom the Stratton Award is named, and George Kimball Burgess, second Director of NBS.*

Measurement of Microwave Power—Con.

being used) that would normally cause a reflection of considerable magnitude, a technique[3, 4] is used that reduces the measurement error to a negligible amount.

The effective efficiency and calibration factor of bolometer units and the calibration factor of bolometer-coupler units are measured with an uncertainty no greater than 1 percent in WR112 waveguide. For these measurements, the element can be of the barretter or thermistor type, and of either 100- or 200-ohm resistance, operating at a bias current between 3.5 and 15 mA. The bolometer units should be of either the fixed-tuned or untuned broadband type. Power measurements can be made on bolometer units over a range of 0.1 to 10 mW.

Power measurements can be made on bolometer-coupler units in WR112 waveguide with coupling ratios from 3 to 20 dB. A bolometer unit of either the fixed-tuned or untuned broadband type must be permanently attached to the side arm of the coupler. The coupler should have a directivity no less than 40 dB, and a VSWR no greater than 1.05 for the input and output ports of the main arm of the coupler.

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[1] *In performing microwave calibrations, a considerable amount of time is usually needed to prepare the system for a measurement operation. Much of this preparation is related to adjustment of the system to the frequency of operation selected for the calibration. Time and cost often can be reduced by minimizing the number of times the operating frequency of the calibration system must be readjusted.*

[2] *G. F. Engen,* A refined x-band microwave microcalorimeter, *NBS J. Res.* **63C,** *77 (1959).*

[3] *G. F. Engen,* A transfer instrument for the intercomparison of microwave power meters, *IRE Trans. Instru. Vol.* **I–9,** *No. 2, 202 (Sept. 1960).*

[4] *G. F. Engen,* A variable impedance power meter and adjustable reflection coefficient standard, *NBS J. Res.* **68C,** *7 (1964).*

PRODUCT STANDARDIZATION UPDATED

■ Bureau procedures for standardizing industrial products have recently been revised. The new procedures will apply to the 40 proposals which the Office of Product Standards has received for new standards, ranging from pressure sensitive tape to wood garage doors. These standards, which are now considered tentative, are being reviewed to assure their technical soundness. When they are found to be generally acceptable by the manufacturers, distributors, and users concerned and in accord with the public interest, they will be published for voluntary use.

The product standardization program was inaugurated by former President Hoover in 1921 when he was Secretary of Commerce. It was designed to provide industry with aid in preparing standards when such aid could not be obtained elsewhere. A panel on engineering and commodity standards of the U.S. Department of Commerce's Technical Advisory Board recently reevaluated the program. The panel recommended the extension of standardizing activities so that Bureau competence could be more advantageously used in this area.[1]

Under the modified product standards procedures, industrial technical committees may initiate the development of new standards. The Bureau reviews each tentative standard and circulates it for comment to groups that would be affected by its publication. The initiating committee considers the comments and makes any changes that have been generally agreed upon.

Recommendations for accepting the standard or for amending it in light of changing circumstances are then made by members of a Standards Review Committee appointed by the U.S. Department of Commerce. The members of this committee should have a broad knowledge of the product, of the standard, and of related industry and trade practices. They are chosen from representative producers, distributors, users, and consumers. After approval of a standard this committee becomes the Standing Committee to consider recommendations to amend, revise, or withdraw the standard.

At the present time, over 450 standards for products in broad categories such as paper, plastics, petroleum, textiles, building materials, wearing apparel, and heating, ventilating, and refrigeration are in voluntary use. The new procedures state that each standard will be reviewed within five years after its initial issuance or its latest revision. Accordingly, over 50 of the standards now in effect are being reevaluated, and a number of revisions will be published. During the next four years, all standards issued between 1926 and 1964 will be reviewed for currency.

Industries, trade associations, professional organizations, or other interested groups may obtain copies of the new procedures from the Office of Product Standards, National Bureau of Standards, Washington, D.C., 20234. The new procedures also appeared in the Federal Register, Vol. 30, No. 238, Friday, December 10, 1965.

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[1] *This report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va., 22151. Section A, price $2, No. PB 166811; Section B, price $6, No. PB 166812. Section A contains major findings and recommendations; Section B contains reports of the various task forces.*

1966 NCSL STANDARDS LABORATORY CONFERENCE

The 3d national conference of the National Conference of Standards Laboratories will be held at the National Bureau of Standards new facility in Gaithersburg, Maryland, Monday May 9 through Thursday May 12, 1966. The meeting will include three days of technical sessions with the fourth day devoted to an inspection of the modern NBS metrology laboratories recently completed and activated at the 560 acre site.

Established in 1961 under NBS sponsorship, NCSL has a membership of 109 organizations. It has held two national meetings—in 1962 at Boulder, Colorado, and in 1964 in New York with ISA—and several specialized workshops. In keeping with its objective of increasing the competence and measurement capabilities of standards laboratories, the 3d NCSL Standards Laboratory Conference will provide an opportunity to discuss problems of measurement and calibration, laboratory organization and procedures, performance requirements, and recommended practices. Write W. R. Tilley, NBS, for further information.

Colorimetric Determination of GASEOUS COMBUSTION PRODUCTS

■ The development of fire extinguishing agents has always been done empirically, because no entirely satisfactory theory exists to explain chemical reactions in flames. Even less is known about the changes in such reactions produced by chemical extinguishing agents. Analysis of the gaseous combustion products is one means of gaining a better understanding of these changes. Such analysis may provide clues to the chemical reactions by which extinguishing agents are degraded to final products.

A study is now under way at the NBS Institute for Applied Technology to gain a better understanding of these changes. In this study [1] E. C. Creitz has developed a colorimetric procedure for the separate determination of HBr and Br_2 which occur as gas-phase constituents of combustion inhibited flames.

Interest has centered on the role of the halogen part (especially bromine) of certain extinguishing agents. In the past, investigators have lacked analytical methods sufficiently sensitive to determine separately HBr and Br_2 when they occur together in combustion products. Previous investigators [2] have shown that mass spectrometric methods are of dubious value for this purpose. In the present study, gas chromatographic columns were investigated, but none proved useful. Finally, a wet-chemical method was developed.

In this method, total bromine from a mixture of HBr and Br_2 is determined by turbidimetric measurement of precipitated silver bromide, after reduction of Br_2 to HBr with sodium sulfite. Br_2 is determined by colorimetric measurement of the yellow oxidation product of *o*-tolidine which can be produced in acid solutions containing both Br_2 and HBr. The concentration of HBr is obtained by subtracting the Br_2 concentration from the value obtained for total bromine. Both gases are absorbed in water and kept in low concentrations so that hydrolysis will help prevent their loss from solution.

The sensitivity of the *o*-tolidine determination of Br_2 is about four times that of the turbidimetric measurement. The overall sensitivity of the method therefore depends primarily on the sensitivity of the turbidimetric measurement of the precipitated silver bromide. The upper limit of the sensitivity of the turbidimetric method—about 5 μg per ml of Br^- ion—is attributed to settling out of the precipitated AgBr. A reproducibility of about 70 ng (nanograms) per ml of Br^- ion was obtained.

The method is now being applied in the analysis of combustion products at NBS. As the determination of Br_2 depends on an oxidation indicator, the presence of reducing agents, or oxidizing agents other than Br_2, may cause interferences. Both oxidizing and reducing gases are known to be present in flames and the reactions with HBr and Br_2 may even be part of the extinguishment mechanism. Such reactions, however, should take place before sample collection and thus should cause little or no interference with the analysis of the final products.

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[1] *For further information, see* Spectrophotometric determination of bromine and hydrogen bromide, *by E. C. Creitz, Anal. Chem.* **37**, *1690–2 (1965).*

[2] *A. Levy, J. W. Droege, J. J. Tighe, and J. F. Foster,* Eighth Symposium (International) on Combustion, *p. 524, Williams and Wilkins Co. Baltimore (1962).*

Publications of the National Bureau of Standards*

Periodicals

Technical News Bulletin, Volume **50,** No. 2, February 1966. 15 cents. Annual subscription: $1.50. 75 cents additional for foreign mailing. Available on a 1-, 2-, or 3-year subscription basis.

Journal of Research of the National Bureau of Standards

Section A. Physics and Chemistry. Issued six times a year. Annual subscription: Domestic, $5; foreign, $6. Single copy, $1.00.

Section B. Mathematics and Mathematical Physics. Issued quarterly. Annual subscription: Domestic, $2.25; foreign, $2.75. Single copy, 75 cents.

Section C. Engineering and Instrumentation. Issued quarterly. Annual subscription: Domestic, $2.75; foreign, $3.50. Single copy, 75 cents.

Current Issues of the Journal of Research

J. Res. NBS **70A** *(Phys. and Chem.), No. 2, (Mar.–Apr. 1966).*

Mechanism of the depolymerization of polytetrafluoroethylene with pyrolytic and radiolytic initiation. R. E. Florin, M. S. Parker, and L. A. Wall.

Effect of some halogenated hydrocarbons on the flame speed of methane. C. Halpern.

Rupture-disk ampoule for anhydrous addition of hydrogen fluoride. A. R. Glasgow, Jr.

Further studies in the annealing of a borosilicate glass. S. Spinner and A. Napolitano.

Infrared spectra of the hydrated borates. C. E. Weir.

Interpretation of the solution absorption spectra of the $(PuO_2)^{++}$ and $(NpO_2)^{+}$ ions. J. C. Eisenstein and M. H. L. Pryce.

Vapor pressure and heat of sublimation of rhenium. E. R. Plante and R. Szwarc.

Steady-state response of silicon radiation detectors of the diffused p-n junction type to x rays. II: Photodiode mode of operation. K. Scharf and J. H. Sparrow.

Absolute isotopic abundance ratios and the atomic weight of a reference sample of chromium. E. R. Shields, T. J. Murphy, E. J. Catanzaro, and E. L. Garner.

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Other NBS Publications

A table of radiation characteristics for uniformly spaced optimum endfire arrays with equal sidelobes, M. T. Ma and D. C. Hyovalti, NBS Mono. 95, (Dec. 10, 1965), 45 cents.

A peak ac-dc voltage comparator for use in a standards laboratory, L. A. Marzetta, NBS Tech. Note 280 (Jan. 17, 1966), 25 cents.

Materials for PLACEBO V, W. C. Watt, NBS Tech. Note 281 (Jan. 17, 1966), 50 cents.

Publications in Other Journals

This column lists all publications by the NBS staff, as soon after issuance as practical. For completeness, earlier references not previously reported may be included from time to time.

CHEMISTRY:

Deuterium isotope effect in vacuum-ultraviolet absorption coefficients of water and methane, A. H. Laufer and J. R. McNesby, Can. J. Chem. **43**, No. 12, 3487–3490 (Dec. 1965).

Electrochemical methods, J. K. Taylor, E. J. Maienthal, and G. Marinenko, Book, Trace Analysis: Physical Methods, Ed. G. H. Morrison, Chapt. 10, pp. 377–433 (Interscience Publ. Inc., New York, N.Y., 1965).

Interaction of oxygen with platinum, A. J. Melmed, J. Appl. Phys. **36**, No. 11, 3691–3692 (Nov. 1965).

Proton transfer reactions occurring in the gas-phase radiolysis, P. Ausloos and S. G. Lias, Discussions Faraday Soc. **39**, 36–44 (1964).

Restoration of complete dentures inadvertently warped by the patient: Report of case, J. B. Woelfel and G. C. Paffenbarger, J. Am. Dental Assoc. **71**, 866–870 (Oct. 1965).

ENGINEERING AND INSTRUMENTATION:

Comment on obscurities of oscillator noise, L. Fey, W. R. Atkinson, and J. Newman, Proc. IEEE Letter **52**, 104–105 (Jan. 1964).

Cryogenic fluid, two-phase critical flow studies related to reactor systems, R. V. Smith, H. S. Isbin, H. K. Fauske, M. Petrick, C. H. Robbins, and F. R. Zuludek, Proc. 3rd United Nations Intern. Conf. Peaceful Uses of Atomic Energy, Geneva, Switzerland, Aug. 31–Sept. 9, 1964.

Field strength calibration techniques at the NBS, H. E. Taggart, IEEE Trans. Electromag. Compatability **EC–7**, No. 2, 163–169 (June 1965).

Field-strength measurements in a multipath field, C. C. Watterson, Proc. 4th Natl. IEEE Symp. Radio Frequency Interference, San Francisco, Calif., June 28–29, 1962.

MATHEMATICS:

A bounded automorphic form of dimension zero is constant, M. I. Knopp, J. Lehner, and M. Newman, Duke Math. J. **32**, No. 3, 457–460 (Sept. 1965).

Density distribution of polymer segments in the vicinity of an absorbing interface, C. A. J. Hoeve, J. Chem. Phys. **43**, No. 9, 3007–3008 (Nov. 1, 1965).

Elastic stress-strain relations in perfect elastic fluids, B. Bernstein, E. Kearsley, and L. Zapas, Trans. Soc. Rheol. **9**, Pt. 1, 27–39 (1965).

Error bounds for asymptotic solutions of second-order differential equations having an irregular singularity of arbitrary rank, F. W. J. Olver and F. Stenger, J. SIAM, Ser. B. 2. No. 2, 244–249 (1965).

PHYSICS:

A stable arc source of high ultraviolet radiance, C. R. Yokley, Proc. Symp. Solar Radiation Simulation, Los Angeles, Calif., Jan. 18–20, 1965, pp. 107–110 (1965).

A latitude survey of the night airglow, T. N. Davis and L. L. Smith, J. Geophys. Res. **70**, No. 5, 1127–1138 (Mar. 1965).

A theoretical study of the Martian and Cyntherian ionospheres, R. B. Norton, Natl. Aeronautic Space Admin. Tech. Note TN D-2333 (1964).

Atomic lifetimes in neon I, J. Z. Klose, Phys. Rev. **141**, No. 1, 181–188 (Jan. 7, 1966).

Coherent Raman effect in the off-axis Raman resonator, D. A. Jennings and H. Takuma, Appl. Phys. Letters **4**, No. 11, 185–186 (June 1964).

Comment on the "Difference between a non-LTE, and a pure absorption, model for the line-blanketing effect," R. N. Thomas, Astrophys. J. **141**, No. 1, 333–335 (Jan. 1965).

Flare importance ratings—some hope for improvement, C. S. Warwick, Proc. Natl. Aeronautic Space Admin. Flare Conf. The Physics of Solar Flares, pp. 27–28 (1964).

Generalized master equation for arbitrary initial states, J. Weinstock, Phys. Rev. **140**, No. 1A, A98–A99 (Oct. 4, 1965).

RADIO SCIENCE

A study of auroral absorption events at the south pole: 2. Conjugate properties, J. K. Hargreaves and H. J. A. Chivers, J. Geophys. Res. **70**, No. 5, 1093–1102 (Mar. 1965).

Characteristic variations in the antarctic ionosphere, V. L. Peterson, G. Stonehocker, and J. W. Wright, Antarctic Research Series, Am. Geophys. Union, Geomagnetism and Aeronomy **4**, 47–75 (1965).

International comparison on dielectric measurements, E. Rushton, G. Russell, B. W. Petley, H. E. Bussey, J. E. Gray, E. C. Bamberger, and D. Morris, IEEE Trans. Instru. Meas. **IM–13**, No. 4, 305–311 (Dec. 1964).

Interrelations of Sporadic E and ionospheric currents, S. Matsushita, Book, Ionospheric Sporadic-E, Ed. E. K. Smith and S. Matsushita, Chapt. II, Pt. C, No. 5, 344–375 (Pergamon Press Inc., New York, N.Y., 1962).

**Publications for which a price is indicated are available by purchase from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402 (foreign postage, one-fourth additional). Reprints from outside journals and the NBS Journal of Research may often be obtained directly from the authors.*

Patents

The following U.S. Patents have recently been granted on NBS inventions and, except as noted, are assigned to the United States of America as represented by the Secretary of Commerce:

3,211,637 October 12, 1965 Homopolymers of 4-chloroperfluoro-heptadiene-1,6. Leo A. Wall and James E. Fearn. (NAVY)

3,218,916 November 23, 1965 Wave front shearing interferometer. James B. Saunders.

3,224,818 December 21, 1965 Combined electromagnetic and electromechanical power converter. Herbert Sixsmith.

3,226,610 December 28, 1965 Constant-current semiconductor device. George G. Harman, Jr.; Theodore Higier; Owen L. Meyer, and Richard L. Raybold.

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